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Summary of Analysis Results for Sediments Provided by Texas A&M University

Cynthia Conrado
Steven Kreek

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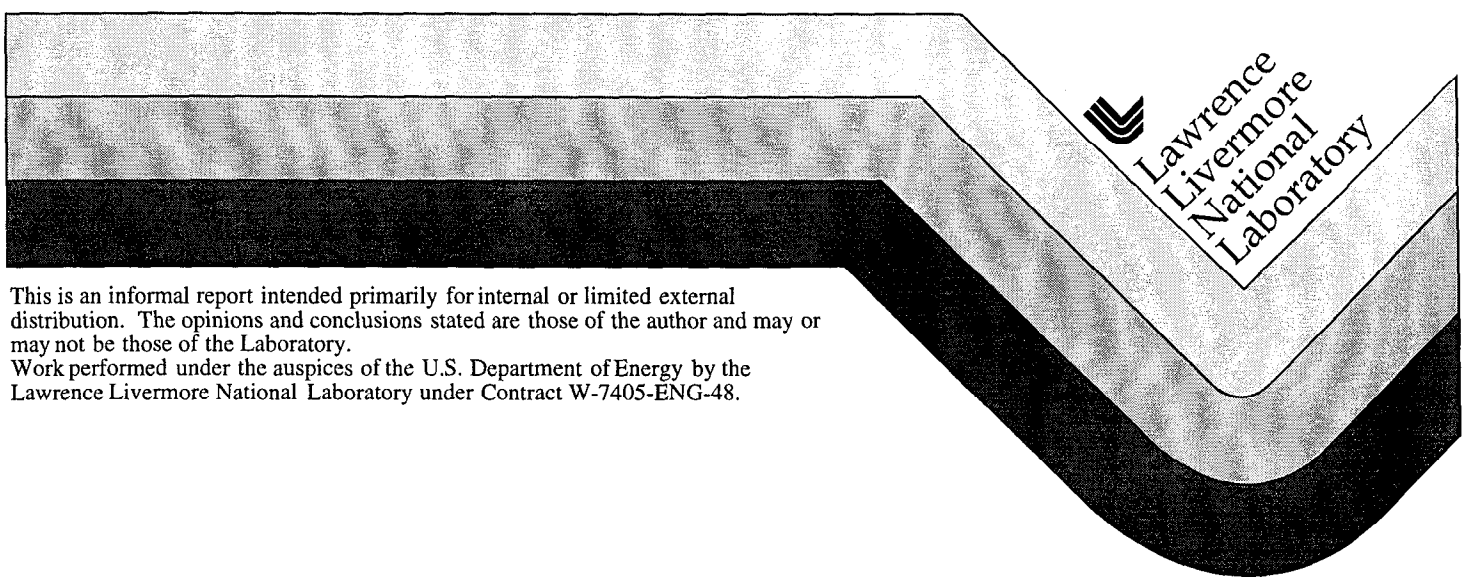

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Summary of Analysis Results for Sediments Provided by Texas A&M University

Cynthia Conrado, Steven Kreek
Analytical and Nuclear Chemistry Division
Lawrence Livermore National Laboratory

Two soil samples were received by the Lawrence Livermore National Laboratory (LLNL) from Texas A&M University (TA&M) for the measurement of low-level ^{226}Ra and ^{228}Ra. This effort was part of a project conducted by the American Petroleum Institute and Gas Research Institute to measure ^{226}Ra and ^{228}Ra in media relevant to offshore oil and gas operations.

The two samples were prepared for counting by packaging each in separate, high-precision, polycarbonate containers. The sample material was then compressed inside each container to minimize Rn migration, the sample weight determined, and a head-space-filling insert emplaced to occupy the vacant space above the sample and provide a tight seal against the top of the sample. The containers were then sealed and the samples set aside for 21 days to permit ^{222}Rn ingrowth. The use of the custom packaging yields counting samples with known cross-sectional area (10.0 cm^2), density, and thickness. Table 1 shows the relevant sample preparation data for the two samples.

Table 1. Relevant sample information for the TA&M samples.

TA&M ID	Sample Weight (g)	Sample Thickness (cm)	Sample Density (g/cm^3)	Sample Area (cm^2)
HS2-1	48.464	4.0	1.212	10
262-1	59.684	4.0	1.492	10

After the 21-day ingrowth period, the samples were each counted by pulse-height analysis 5 times with 5 high-purity germanium (HPGe) detector systems in the Analytical and Nuclear Chemistry Counting Facility[1] (NCCF) at LLNL. Each sample was counted for 5 days and the spectra collected over the energy range of about 50 keV to about 2 MeV and the raw data stored in a central database for future analysis.

[1]. The NCCF is an extensive radiation measurement facility at LLNL and has capability to measure virtually any kind of radioactivity.

The LLNL gamma-ray data interpretation program used to identify and quantify radionuclides measured by gamma-ray spectrometry is called GAMANAL.[2] This code employs a geometric model (distance to sample, sample dimensions, etc.), and combines radiation transport physics with the sample specific information (thickness, density, average Z, etc.) and the intrinsic characteristics of each HPGe detector (intrinsic efficiency, active detector volume, Ge dead layer, peak shape, resolution, etc.) to determine the counting efficiency of each measurement. In addition to the specific information provided in Table 1, other sample parameters considered are the zero-time (September 11, 1997 for these samples) and composition of the container (for radiation attenuation correction, approximated as 0.12 g/cm^2 H_2O for the container used in this case). The method employed by LLNL is more robust than is generally found in a commercial analytical environment because GAMANAL does not require physical standards which approximate the samples in every way to perform an efficiency calibration. LLNL uses this method because many situations do not lend themselves to the creation of standards which nearly duplicate the samples of interest. Instead, LLNL calibrates against NIST traceable point sources and determines the intrinsic efficiency of each HPGe detector. The use of the intrinsic characteristics of the HPGe detector and a geometric model reduces the frequency with which the detector systems must be calibrated.

The data interpretation process is performed by the code GAMANAL. This code reads the spectral data, determines the background, locates the peak regions, determines the gamma-ray energies and intensities, corrects the measured gamma-ray intensities for attenuation (sample and container), selects all likely component nuclides, performs a least-squares matrix inversion calculation for each set of possible interferences, and computes the final activity present per unit weight of sample. Because each sample was counted on five different detectors, the weighted average and standard deviation was calculated for each isotope identified from the 5 independent measurements. Table 2 presents the weighted averages of the isotopes reported in the samples, HS2-1 and 262-1. The error-weighted averages were calculated using the method described in the Nuclear Data Tables. As can be interpreted from the reported uncertainties in Table 2, these samples contain an easily detectable quantity of the relevant radionuclides.

Table 2. Radium concentration in picoCuries (pCi/g) sample material. Note that the samples were not dried extensively prior to measurement. Errors are 1 sigma.

Sample ID	^{226}Ra concentration (pCi/g)	^{228}Ra concentration (pCi/g)
HS2-1	0.79 ± 0.90%	1.22 ± 1.1%
262-1	0.91 ± 0.76%	1.09 ± 1.1%

[2] J. B. Niday and R. Gunnink, "A Gamma-Ray Spectral Interpretation Code, GAMANAL," Lawrence Livermore National Laboratory Report Number, UCRL-51061, 1972.